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Evaluation of New Methods of

Nonferrous Mining

Rumanian Monthly Periodical
Bucharest
August 1951

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EVALUATION OF NEW METHODS OF NONFERROUS MINING, Bucharest, Revista Minelor, Aug 51

[Illustrations not reproduced.]

Soviet methods of nonferrous mining introduced in Rumania ~~in Rumania~~ in 1950 are as follows:

a. Inclined slices,

b. Teams using many drills,

c. Injection of water,

d. Drilling , use of water pressure, and active chemicals.

Among these methods the one which has proved to be most adaptable for large scale use in Rumania is the inclined slice method. This method used in conjunction with the others mentioned above has resulted in plan fulfillments of 103.6 percent, 105.1 percent, and 106.3 percent. In the region which achieved such results the 1950 production was as much greater than the 1949 output as though a new medium (size) mine had been placed in operation. This particular region used the inclined slice method with support by stulls and pillars of rock.

Methods of Mining Used

The preferred method for gold-silver veins, for complex minerals, and pyrites was the horizontal stope method, without stulls or with partial stulls, or in some cases with stulls.

The inclined slice method was introduced in a sporadic manner in 1949 in the mining region mentioned above. [article does not state which region] At first it was used by only three mines. It was extended to almost all mines of the combine of the region in 1950. In January 1950 there were four inclined slice mines. This increased to nine by the end of 1950.

The use of uncut rock supports was tested at one mine then spread to 14 by December 1950.

~~DESCRIPTION~~ of Methods Used

The various new methods used may be described as follows:

a. The horizontal stoping method illustrated in figure one makes use of a face 30 meters in length. This can be increased to 60 meters, however. The height of the face between drifts varies from 30-50 meters. The distance between shafts is approximately 10-20 meters. The shafts are cribbed with wood frames. Some shafts have stone walls, however. The preparation of the face under normal conditions is done by leaving a safetly foot of 1.5-2 meters in the lower drift and by the construction of chutes at respective distances. Work is done by means of 2-3 cuts at a time, with a total height of 2-3 meters. Stowing is done by means of advancing steps. Cutting is performed manually. The broken ore is scooped down the cute.

A variation of this method of horizontal stoping is the use of a bridge (or scaffold) instead of a stull. Bridges are separated from one another 2 meters vertically. The mineral is brought from a lower to a higher bridge. The bridge is constructed on tracks at intervals of 1-1.2 meters. This method is used frequently, because it permits greater speed of exploitation of the face and solves the stowing problem. A disadvantage of the bridge method, however, is the reduced safety for workers, especially at higher levels along the face. The scaffolding or bridges require greater amounts of mine timbers as represented by the formula .032 m^3/t (cubic meters per ton) of the face, as compared to .016 m^3/t by the use of stowing in a vein 1.20 meters thick.

b. Inclined slicing was introduced into the region comparatively recently, but has already shown advantages such as greater production and productivity, and lower production costs. The face in this method has a length of up to 90 meters and is bordered by two chutes. The face is 30-50 meters high. A shaft linking the upeer and lower drifts is in the middle of the face. This shaft feeds stow and waste rock, permits personnel traffic, and

contains a conduit for compressed air and water. The shaft is cribbed with timbers. Preparation for the working of this type of face consists of the removal of 2-meter strips from the roof of the lowest drift and the reinforcement of the drift with timbers. At first a safety column of 2 meters was left standing. This was subsequently found to be unnecessary, however, especially in thin veins. This method is characterized by the cutting of an inclined plane at about the natural angle of the slope of the mineral stratum, usually 35-40 degress. Inclined drifts branch away from the main shaft. These drifts are worked alternately. When one is being cut, the other is reinforced. The excavation of minerals is done by a chute of wood or sheeting placed along the whole length of the inclined drift. Thus the removal of the minerals is facilitated by gravity. Stulling consists of waste rock. An inclined drift can be cut either from above or below. Drilling is horizontal with or without steps. Blasting is done with the aid of electric cables.

The work is performed in three phases: drilling with 3-4 drills normally, or 6 drills when increased speed is desired.

c. The underground storage of minerals was introduced from the USSR where it is widely used. This method was used in Rumania at only a single mine during the last decade. On the basis of experience gained at this mine it was possible to extend the method, however. The face has a length of 60 meters and a height of 30-40 meters. It is bordered by two chutes with or without supports between the chute and the cuttings. In the middle of the face there is a shaft reinforced with wood. The reinforcement of this shaft is done as the cutting rises. Experience has shown that no supporting pillar is necessary at the base of the cutting and between the cutting and the transport drift. In wider veins the lower drifts is precut, that is to say, a 2-meter high strip is removed and the drift is then reinforced. Pillars are placed at a distance of 5-8 meters from one another. In this method, the mineral which is removed from the face by blasting remains where it fell, constituting a type of stow in the resulting hole. A certain

amount of mineral is removed after blasting. Drilling is done horizontally.

Application of New Methods

Each of the methods examined requires certain conditions in order to be effective. Thus, for example, in the horizontal stope method with stulling is used where the vein is irregular, with poor walls, and where rock is found in the vein. The scaffold method requires strong walls and a vein from which the mineral can be cut in layers. It is preferable in veins with a thickness of less than 1.5 meters.

The inclined slice method is applied to veins which are capable of more regular exploitation. The inclined drift method is used in veins from .7-7 meters, and is especially recommended for veins more than 4 meters thick. The inclined drift method permits more favorable air currents, the feeding of stow through two lateral shafts, and assures a greater quantity of stow.

The underground storage method is applied where the mineral deposit is uniform and where floors and ceilings are hard. The mineral must be dry, for moisture will cause cementation and hardening. This is the case with complex sulfur deposits and kaolins, although cementation does not usually occur with mineral-bearing quartz. A variation of this method is being studied so that it could be used in veins which contain rock. The productivity of underground storage exploitation increases with the size of the vein, since most of the labor involved is escavation.

Figure four is a graph showing the success of different methods used in large veins in the region under discussion. The speed of drilling is taken as 5-10 centimeters per minute, an average for the region.

Figure five shows the varied results obtained with the underground storage method with very hard rock. This represents average data for the first 7 months of 1951, obtained at mine X, which has complex minerals, and mine Y which has quartz-gold-silver veins. The difference in results obtained by the two mines is due to the different coefficient of resistance and to the different degrees of utilization of the two mines.

Advantages of the New Methods

a. The inclined drift and the underground storage methods offer the possibility of 50-100 percent greater production than older methods.

b. The methods permit rationalization of exploitation and a greater concentration of cutting.

The following figures show the results of the use of various methods in 11 months of 1950 at one mine:

Old Methods

Old pick and mine hammer method	253 tons
Stowing	206 "
average	211 "

New Methods

Inclined drift	206 "
Underground storage	494 "

The average monthly production of a face exploited by the new methods is approximately double the average production under the old method.

Table one , reproduced below, gives more complete data on figures for the same mine as above:

Table One; Production Obtained by Different Means of Exploitation

Methods	Maximum tonnage	cubic meters	Place of Work	Remarks
Pick and Hammer	569	177.8	A	Vein 1.7 meters thick
Stowing	686	208.3	B	
Inclined drifts	1,405	484.5	C	
Underground storage	1,195	409.9	D	Vein 2.7 meters thick

A stope that can give more than 1,000 tons per month represents a strong aid to the fulfillment of the production plan.

c) Another advantage of the inclined drift and the underground storage methods is the possibility of using many drills. This raises the speed of

exploitation of a face, and permits the better utilization of workment

d. The inclined ~~stope~~ drift and underground storage method could permit exploitation of small veins of .6-1 meter thickness.

e. The ~~mining~~ underground storage method assures the existence of a stockpile of minerals underground.

f. The new methods bring two additional advantages. First they lead to uniform production in regard to quality and to the analyzing of mineral samples from all parts of the stratum. Secondly they facilitate the recovery process at the processing plant.

g. The new methods cut production costs

Comparison of Indexes

Indexes for evaluating the new methods are as follows:

a. Index for the distribution of production

b. Index of productivity

c. Index of consumption of basic ~~raw~~ materials

d. Index of production costs.

a. Index of distribution of production

The distribution of production in tons for one of the mines in the region under discussion is as follows:

From basic work 24.5 percent

From preparation 9.3 "

From cutting 66.2 "

Distribution of production according to method of exploitation was as follows:

Old Methods

By pick and hammer 17 ~~21.5~~ percent

By stowing 28.7 "

New Methods

By inclined ~~stope~~ drift about 25.6 percent

By underground storage 28.7 "

In the entire region 45.6 percent of production came from new methods.

b. Index of Productivity

An analysis of 11 months production at the mine examined above, shows the average productivity to be as follows:

Old Methods	ton per work location	cubic meters per work location
Pick and hammer	1.74	.64
Stowing	1.63	.49
average total	1.66	.54
New Methods		
Inclined diff	2.51	.86
Underground storage	3.29	1.12

The comparative yield of the various methods is as follows:

Method	percentage by tons per work location	percentage by tons per cubic meter
Old methods	100	100
Inclined stope	149.5	159.3
Underground storage	195.8	207.1

The two new methods offer the worker a larger wage because of greater production.

The following table represents norm fulfillments according to the various methods over an 11 month period:

Old Methods			New Methods		
Pick and Hammer percent	Stowing percent	Total percent	Inclined diff percent	Underground storage percent	Total percent
14.8	18.9	18.0	39.5	--	21.3
23.4	22.5	22.5	35.5	24.2	24.6
--	21.5	21.5	40.2	--	20.0
60.8	41.1	47.6	25.2	30.1	41.5
16.0	25.7	24.2	34.8	50.0	33.5
30.5	34.9	33.3	31.0	30.7	32.2
35.1	33.3	34.1	72.3	55.1	47.2

35.1	33.3	34.1	72.3	55.1	47.2
38.5	38.0	38.2	44.8	47.8	41.6
41.3	33.6	38.5	27.7	52.5	38.4
29.1	42.6	38.2	63.0	44.5	47.6
33.4	50.2	39.5	72.5	85.0	65.4
Average for 11 months					
34.8	32.2	33.2	48.0	48.9	40.3

c. Index of Consumption

The index of use of explosives is lowest in the inclined ~~stope~~ drift method. The underground storage method requires as much explosive as old methods. The average result for an 11 month period in the use of explosives is as follows:

Old Methods:	Use of Explosives	
	kilograms per ton	kilograms per cubic meter
Pick and hammer	about .53	1.61
Stowing	.34	1.06
average	.41	1.26
New Methods:		
Inclined ~~stope~~ drift	.37	1.09
Underground storage	.43	1.26

The index of the comparative use of explosives was as follows:

Method	percentage by kilogram per ton	Percentage by kilograms per cubic meter
Old methods	100	100
Inclined ~~stope~~ drift	89.5	87
Underground storage	105	100

The use of explosives in the horizontal stope method is much lower since smaller areas are worked and therefore better use is made of explosives. In computing the use of explosives one kilogram of astralite is regarded as the equivalent of .75 kilograms of dynamite.

The consumption of mine timbers was as follows:

Method	Utilization		Comparative Indexes	
	cubic meters per ton	cubic meters per cubic meter	percent	percent
Old methods	.222	.068	100	100
Inclined drift	.0070	.023	35.5	33.8
Underground storage	.002	.006	9.1	8.8

d. Cost of Production by component is as follows:

Cost of Labor

	Wage per day of work
Old Methods	
Pick and hammer	319
Stowing	312
Total	316
New Methods	
Inclined drift	252
Underground storage	190

Cost of Basic Materials (timber, explosives)

Method	Lei per Ton		
	Explosives	Wood	Total
Old methods	155	53	205
Inclined drift	142	19	161
Underground storage	163	5	168

Method	Cost of Production in Lei per Ton		
	Wages	Materials	Totals
Old methods	316	208	324
Inclined drift	252	161	413
Underground storage	190	168	358

END